REMARKS

Office Action

The paragraphing of the Examiner is adopted.

The claims have been amended as required by the Examiner, and claim 18 has been amended to recite BET based on paragraph 11 of the specification.

Paragraph 2 (Specification)

The Examiner objects to the introduction of "free of silver and silver compounds" into the specification.

Applicants understand the Examiner to be referring to the Abstract, and have amended the Abstract to remove this recitation.

Paragraph 3 (Claim Rejections - 35 USC § 112)

The Examiner objects to the introduction of "free of silver and silver compounds" into claim 9.

Applicants have removed this language from claim 9.

The Examiner points out that if claim 9 were amended, claim 18 would be duplicative.

In response, Applicants have amended claim 18 to recite BET value of the carrier substance.

Paragraph 4 (Claim Rejections - 35 USC § 103)

Claims 9-18 are rejected under 35 U.S.C. 103(a) as being

obvious over EP 0 890 389 A1.

Applicants respectfully traverse in view of the claims as returned to their original scope.

Briefly reviewing, Applicants in the first Amendment attempted to point out that the denitrification mechanism of EP 0 890 389 A1 required silver for nitrogen storage, whereas the present solid used a mechanism involving the combination of a high level of zirconium oxide and a rhodium catalyst. Applicants amended the claims to exclude silver. The Examiner determined this negative limitation to be new matter thus not a valid basis for distinguishing the present invention.

Applicants now revert to the original claim limitations to distinguish over this reference. More specifically, claim 9 requires a nitrogen oxide storing and catalytically effective solid which comprises

(1) a porous carrier substance comprised of **at least 50 wt.% zirconium oxide** and

(2) **rhodium** which is provided on the porous carrier substance.

(3) is **free of alkali earth metals, alkali metals and rare earth**

EP 0 890 389 A1 does not teach any of these essential limitations, all of which must be present in combination in order for the present invention to work.

The present solid must be **free** of alkali earth metals, alkali metals and rare earth (Li, Na, K, Rb, Cs, Fr, Ca, Sr, Ba, Ra, Sc, Y and La - Lu including Ce). Perhaps the most popular support for NOx storage catalytic converters is ceria (ceric oxide). EP 0 890 389 A1 teaches that the microporous carrier

substances many be Al_2O_3, **CeO_2**, **La-containing CeO_2**, ZrO_2, La-containing ZrO_2, SiO_2, TiO_2, Mg-Al-mixed oxide, Si-Al-mixed oxide, and zeolite. Thus, EP 0 890 389 A1 does not teach this limitation.

EP 0 890 389 broadly lists noble metals (Pt, Pd, Rh, Ir, Au, Ru, Os). The combination of greater than 50 wt% zirconium oxide as carrier and rhodium as the catalyst are nowhere to be found in EP 0 890 389 A1.

The Examiner is requested to note the discussion at page 1 of the present specification describing the composition and limitations of the prior art material of EP 0 890 389 A1. This reference teaches an **Ag**-Al_2O_3//Pt/Rh-**Al_2O_3** type catalyst. Al_2O_3 does not perform any storage function. EP 0 890 389 A1 thus requires "Ag- und edelmetallhaltigen Verbindungen" - silver and preferably additionally rare earth metal compounds.

Applicants have searched the prior art and have found no patent disclosing this invention.

US Patent 6,150,299 teaches that three-way catalysts for simultaneously eliminating hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxides (NOx) from exhaust gases emitted from internal-combustion engines of automobiles and the like generally comprise a platinum group element such as platinum, **rhodium** or palladium, in combination with **cerium oxide** having oxidation-reduction performance (oxygen storing effect) and serving to improve the low-temperature catalyst activity. At high temperatures cerium oxide grain size grows (crystallization) and activity drops. It is known to add zirconium oxide to in inhibit crystallization, but after exposure to high temperatures

(1000ºC) BET is at most 20 m^2/g. This problem is overcome by formulating the carrier to have the composition:

50 to 79% by weight as cerium oxide,

20 to 49% by weight as zirconium oxide and

1 to 5% by weight as sulfate (SO_4).

Thus, there is no teaching of the combination of (1) a porous carrier substance comprised of at least 50 wt.% zirconium oxide, (2) rhodium as catalyst, and (3) freedom from alkali earth metals, alkali metals and rare earth.

US Patent 6,255,249 teaches an oxidation catalyst for diesel engine exhaust, comprising a platinum group metal dispersed on a refractory metal oxide support such as titania, zirconia, ceria-zirconia, silica, alumina-silica or alpha-alumina, with a BET of at least 10 m^2/g. This reference was published June 3, 2001, nowhere mentions rhodium, and does not mention amount of zirconium oxide, and is not free of alkali earth metals, alkali metals and rare earth.

US Patent 6,103,660 teaches a method for depositing a catalyst on a high surface area support material, wherein the support material may be, e.g., a coprecipitated cerium/zirconium mixed oxide with a BET surface of 60 m^2/g. There is no specific mention of rhodium or exclusion of alkali earth metals, alkali metals and rare earth.

US Patent 3,899,444 teaches an inert substrate which according to the claims and abstract is an alumina impregnated one or more times with an aqueous solution of a catalytic metal compound, a rare earth metal compound **and an aluminum compound**, said compounds being thermally decomposable to oxides; the atom

ratio of catalytic metal to rare earth metal to aluminum in the impregnating solution being 0.1-1 to 0.8-1.4 to 8-20. The impregnating solution can **optionally** contain a **small amount** of noble metal compounds such as rhodium, platinum or palladium, **preferably palladium**, to improve low temperature activity. According to the bottom of col. 12, an **inert substrate** may optionally be an inert zirconia, silica-alumina, mangesia, clay (e.g., mullite), aluminum magnesium silicate, and the like. Thus, this patent recites a laundry list of catalysts and supports, and does not lead to the present specific combination of at least 50% zirconium oxide carrier plus rhodium catalyst.

US Patent 5,883,037 teaches catalyst compositions for catalytic conversion of exhaust gasses, comprising alumina, the oxides of cerium praseodymium and zirconium, and, optionally, at least one other oxide of bismuth, of a rare earth, or of an element of group VIII of the Periodic Table. There is no specific mention of rhodium. Further, the carrier comprises at least 50% by weight of cerium, relative to the total amount of cerium, praseodymium, iron and zirconium oxides, thus negating the possibility of the at least 50 wt.% zirconium oxide according to the present invention.

US Patent 5,550,096 teaches a catalyst for purifying nitrogen oxides from exhaust and waste gasses, the catalyst comprising

(A) 80 to 95% by weight of a sulfur oxide-containing catalytic oxide obtained by thermally treating at least one hydrous oxide compound selected from the group consisting of

- binary hydrous oxide compound of titanium and silicon,
- binary hydrous oxide compound of titanium and zirconium and
- ternary hydrous oxide compound of titanium, zirconium and silicon

in the presence of at least one sulfur compound selected from the group consisting of sulfuric acid and ammonium sulfate,

(B) 0 to 5% by weight of a **catalytic oxide** comprising vanadium oxide, and

(C) 1 to 15% by weight of a catalytic oxide comprising the oxide of at least one metal selected from the group consisting of tungsten, molybdenum, tin and cerium.

There is no mention of rhodium, or the requirement for the carrier to comprise at least 50 wt.% zirconium oxide, or absence of alkali earth metals, alkali metals and rare earth according to the present invention.

US Patent 5,120,695 claim 10 teaches an oxidation catalyst for removing nitrogen oxides, comprising

2 to 70 wt.% CeO_2 and **0 to 20 wt % ZrO_2** and, optionally, iron oxide, alkaline earth metal oxides and/or aluminum oxide of the transition series containing rare earth-metal oxides as the carrier, and

an active phase applied to the carrier and comprising 0.01 to 3 wt.% of platinum, palladium and/or **rhodium**, the ratio by weight of platinum, palladium and/or palladium to rhodium, if present, being from 2 : 1 to 30 : 1.

Thus, the amount of zirconium oxide is much less than the 50% presently employed.

US Patent 5,997,830 teaches as background that a method is known wherein a catalyst comprising a noble metal, such as Pd, Pt, and Rh, supported on a porous metal oxide carrier, such as zeolite, alumina, silica, and titania, is used (Japanese Pre-examination Patent Publication (KOKAI) Nos. 3-221143 and 3-221144). These catalysts are required to have various characteristics, and since in some cases the exhaust gas from a lean burn engine reaches a temperature of 700º C. or more, and in particular in the case of the exhaust gas from an engine for transport vehicles, such as buses, trucks, and passenger cars, the temperature of the exhaust gas sometimes reaches as high as about 800 to 900º C. temporarily during the operation because the load on the engine changes violently, the catalyst for purifying exhaust gas is demanded to have heat resistance at such a high temperature. In addition, a long-term reliability to the extent of 100,000 to 160,000-kilometer mileage is demanded. However, the catalyst has defects in that it allows conversion of NO_x at a relatively low temperature of 200º C. to 300º C., the catalyst has problems that the effective temperature range is narrow and a considerable amount of N_2O is produced concomitantly as a partial reduction product of N_xO. There is also disclosure that a two-stage catalyst system is known wherein a catalyst comprising rhodium or iridium is placed in the upper stream and a catalyst comprising platinum or palladium is placed in the lower stream (Japanese Pre-examination Patent Publication

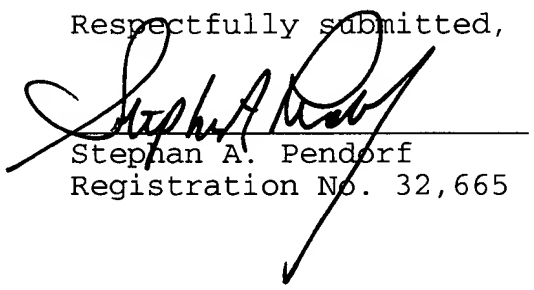
(KOKAI) No. 52-65177). However, this catalyst system is intended to purify exhaust gas from an internal combustion engine that is operated at an air/fuel ratio of about 14.6 where the reducing components and the oxidizing components in the exhaust gas are equivalent, so that the catalyst system is not effective to purify the exhaust gas from lean burn engines that are operated in the presence of excess oxygen and the removal of NO_x scarcely proceeds.

Accordingly, an extensive review of the current state of the art leads only to the conclusion that the present invention is not obvious.

Withdrawal of the rejection is respectfully requested.

Entry and favorable consideration prior to consideration are respectfully requested.

Respectfully submitted,



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CERTIFICATE OF MAILING AND AUTHORIZATION TO CHARGE

I hereby certify that the foregoing AMENDMENT B for U.S. Application No. 09/912,004 filed July 24, 2001, were deposited in first class U.S. mail, postage prepaid, **Mail Stop: AF,** Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on **December 11, 2003.**

The Commissioner is hereby authorized to charge any additional fees which may be required at any time during the prosecution of this application without specific authorization, or credit any overpayment, to Deposit Account No. 16-0877.

Stephan A. Pendorf